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VARIATION OF REMANENT FIELD WITH PEAK EXCITATION IN MAIN RING B2-MAGNETS

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A study was made to investigate changes which occur in the remanent fields of the main-ring magnets when a change is made in the peak excitation. The magnets used for these studies were main ring B2 dipoles (2313 and 2317). Prior history of these magnets included standard production testing. For the first test the magnet was trained by pulsing it for 10 minutes at a fixed peak current. The remanent field was then measured at 3 points across the horizontal aperture (x = -1, 0, +1 in.). An F. W. Bell Model 811 Gaussmeter and Hall probe were used to detect the field (Model HTL-8-0618, Serial 78773). The results are shown in Table I. Note that the remanent field shows a slight decrease from turn-off to 5 minutes after turn-off. This relaxation effect is always present in iron core magnets. The second point to notice is the gradual increase in the remanent field accompanying each decrease in the peak excitation current. It is clear from these results that no degaussing takes place simply by lowering the peak current without a change of polarity between pulses.

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Table I. Remanent Fields in Main Ring Dipole 2312, 10 Minute Training Period at Each Peak Current. Remanent Field in Gauss.

	x = +1	0	-1	Peak Current for Training (~200 Pulses) A
0	11.83	11.93	11.83	6900
+5 min.	11.79	11.87	11.77	
	12.23	12.35	12.23	4750
	12.23	12.35	12.23	
	12.09	12.20	12.08	5500
	12.07	12.17	12.07	
	12.27	12.39	12.27	4800
	12.24	12.36	12.23	
	12.7[illegible]	12.91	12.73	3200
	12.72	12.87	12.71	
	12.79	12.97	12.78	2300
	12.77	12.95	12.75	
	12.89	13.06	12.87	1100
	12.86	13.05	12.85	

In order to rule out hysteresis effects that may be introduced by the Hall probe, another test was made using a different B2 magnet, only this time the 20-ft stretched-wire probe was also used to detect the field. As before, this magnet had previously been subjected to standard production testing. The first training cycle was 40 pulses at 22.5 kG peak field. This was followed by a series of single pulses each to a lower peak field than the previous pulse. The stretched-wire probe was positioned at x = +1.0 in. from center, and three measurements taken after each pulse.

Table II.* Remanent Fields in Main Ring Dipole 2317.

# of Pulses	Peak Field	Remanent Field S. W. Probe (Gauss)			Hall Probe
40	22.5	11.81	11.84	11.77	15.20
1	21.4	11.96	11.78	11.83	--
1	19.89	12.17	12.08	11.99	15.20
1	18.05	12.39	--	12.33	15.30
1	16.00	12.67	12.74	12.65	15.47
1	14.04	12.95	12.89	12.77	15.43
1	12.13	13.16	13.14	12.96	15.50
1	10.10	13.23	13.26	13.22	15.60
1	8.07	13.11	13.23	13.23	15.80
1	6.03	13.44	13.41	13.17	15.73
1	4.01	13.42	13.41	13.45	16.00
1	2.01	13.45	13.38	13.35	16.05
1	1.01	13.38	13.23	13.32	16.07

*Original data for this run is attached.

The Hall probe measurements in Table II were taken in a subsequent but identical cycle to that used for the stretched-wire probe. The absolute difference between them is of no significance since one measures field at a point and the other detects the average field. What is significant, however, is that both of these measurements indicate an increase in remanent field as the peak field between cycles is reduced in agreement with the results presented in Table I.

In conclusion one can say that no degaussing of a magnet takes place unless the magnet is driven with currents of polarity opposite to that with which it was initially excited. Furthermore, to induce the maximum remanent field in a magnet, one should begin by pulsing well into saturation, and then continue to pulse while gradually lowering the currents (without changing polarity). This says that lower current pulses have no significant effect on the remanent field induced by preceding higher pulses, but rather appear to establish additional remanent field by themselves which are very much affected by succeeding pulses to higher currents. This is verified by the fact that the remanent field would always return to the same value after pulsing to the maximum field of 22.5 kG following the runs as presented in Tables I and II.

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Subject Remnant field stability of #2317 **Instructor's Name**

Using S.W. probe into Pilchinsk 300K, Analog out of Dana 5700 using 100X, with Pachinks program.

Pulsed magnet for 10 min to 22.5 KG 1320
Let magnet set for 5 min no power 1325

Positioned S.W. Probe at x = +1.0 ins.

No. Pulses	Max Pulse	Remnant	Time		Time
40	22.5	11.81, 11.84, 11.77	1325	15.20	1530
1	21.4	11.96, 11.78, 11.83	1330	~~15.20~~	
1	19.89	12.17, 12.08, 11.99	1334	15.20	
1	18.05	12.39, —, 12.33	1336	15.30	
1	16.00	12.67, 12.74, 12.65	1340	15.47	
1	14.04	12.95, 12.89, 12.77	1345	15.43	
1	12.13	13.16, 13.14, 12.96	1348	15.50	
1	10.10	13.23, 13.26, 13.22	1352	15.60	
1	8.07	13.11, 13.23, 13.23	1356	15.80	
1	6.03	13.44, 13.41, 13.17	1400	15.73	
1	4.01	13.42, 13.41, 13.45	1402	16.00	
1	2.01	13.45, 13.38, 13.35	1405	16.05	
1	1.01	13.38, 13.23, 13.32	1408	16.07	1535
				15.41 after Trim at 13.5	

Set to pulse at 13.9 KG for 10 min 1425 Pulse varies 13.5-13.9 KG

40	13.9	12.92, 12.88, 12.65	1428

Set to pulse at 13.9 KG for 5 min
Last pulse 0-13.9-.4-.5-0 13.08, 12.85 1438

Set to pulse at 13.9 KG for 5 min
Last pulse 0-13.9-.27-.52-0 13.10, 13.02, 13.01 1445-1449

Set to pulse at 13.9 KG for 5 min 1455 15.93 Gaussmeter
Last pulse 0-13.9-.10-.50-0 12.96, 13.08, 13.19 1500

Set to pulse at 13.9 KG for 5 min 1506 15.93-15.89
0-13.93 .09-.53-0 13.08, 13.07, 13.13 1510

Set to pulse at 13.9 KG for 5 min 1516 15.45-15.43
12.55, 12.55, 12.73 1519